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REVIEW

FORAGE RESOURCE UTILIZATION AND MANAGEMENT FOR GREATER RUMINANT PRODUCTION: A REVIEW

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The objective of the paper was to review forage resource utilization and management for greater ruminant production in tropical Africa. There are about 32.42 and 39.41 million hectares of grazing and crop lands in Nigeria, respectively, which provide substantial amount of feed for the country's livestock industry. Extensive parts of the grazing lands are composed of indigenous species, which are of low yield, quality and seasonal in growth. There is, therefore, the need to increase the production of the forage crops especially in Northern Nigeria to meet the ever increasing livestock population in the last few years. Over the years, therefore, many improved varieties of forage have been introduced by research institutes, Federal and State Governments with the aim of improving the natural pastures and providing more nutritious feed to the national herds. There is however, the need to develop or adopt strategies that will assist these introduced forage species to cope with and even overcome most of the factors that militate against high productivity. Such technologies should take into consideration the peculiarities of various agro-ecological zones in which these forage and fodder crops grow, in order to obtain useful results for dissemination to livestock producers. The technologies should put into consideration the recently heightened tensions between Nigeria's Fulani herdsmen and settled indigenous farmers as a result of the dwindling natural resources and land availability, greatly contributing to the on-going, escalating conflict in the country.

Keywords: Forage, Management, Ruminant Animals, Tropical Africa.

INTRODUCTION

Nigeria has a land area of 92.4 million hectares of which about 44% are under permanent pastures that supports its domestic ruminants of over 101 million. It is estimated that, only about 3% of this number of animals are reared on improved pastures (intensive management); the remaining 97% are raised on low nutrient native pastures and farmlands (under extensive management). Grazing lands in Nigeria, including natural wetlands (fadama), grass and woodlands and forest reserves are estimated to cover about 32.42 million hectares, while cultivated crop-lands amount to about 39.41 million hectares. These lands provide substantial amount of forage and fodder as major sources of feed for the country's ruminant livestock, both domestic and wildlife (Gómez, 2013; Olawoye and Kubkomawa,

2018).

In Nigeria, forage quality and availability vary greatly from season to season, which affects the output of the animals. The nutritive value of pastures fall rapidly with maturity and during the dry season the available feed is lignified. Likewise, protein, nitrogen, sulphur, vitamins and other nutrients are limited in grassland pastures during the dry season, while fibre is high with dry matter content of more than 30%. The nutritive value of any feedstuff is determined by its chemical composition and its digestibility and this is related to the forage and its environment. The rate of acceptability of forage is related to the readiness to which the forage is selected and consumed (Gómez, 2013; Olawoye and Kubkomawa, 2018).

Farm animals require nutrients to support body maintenance, reproduction, lactation, and growth. The nutritional needs of livestock vary according to breed, age, sex, class, stage of production, performance level and weight. Physiological and environmental stressors, such as sickness and weather, can also influence nutritional requirements. In spite of the infertile soils and hostile climatic environment, ruminant livestock survival in Northern Nigeria largely still depends on the extensive native pastures, browses and crop residues found across and within the various agro-ecological zones. Nigeria's forage and fodder species vary widely and are spread across the major agro-ecological zones of the country. Extensive areas of Nigeria's grazing lands are composed of indigenous forage species with their various botanical characteristics (Ndathi et al., 2012).

Most of the species grown, until recently, are of the indigenous or local varieties that often have very low yields. Long periods of cropping, rough topography and frequent bush burning, among other factors, have given rise to mixed tree, shrub and grass vegetation in the savannah zones of the country. The grasses are composed of both annuals and perennials, and the trees show features characteristic of plants growing in low rainfall areas (Olivo et al., 2013). Various nutrients and minerals, such as nitrogen, phosphorus and potassium among others, have also been found to be a key limiting factor in the proper development of forage and fodder crops, and hence the efficient utilization of these crops by livestock (Olawoye and Kubkomawa, 2018). The objective of the paper was to review forage resource utilization and management for greater ruminant production in tropical Africa.

PASTURE AND RANGE MANAGEMENT

Pasture

Pasture is any area of land containing herbage (grass and legumes) needed for feeding farm animals (UFS, 2014). The animals may graze on the herbage, or the herbage can be harvested or cut and fed to the animals in the stall or pen, where the herbage is consumed fresh (Olawoye and Kubkomawa, 2018).

There two types of pasture found in the world, these include: Artificial pasture refers to an area of land covered with forage grasses and legumes which are deliberately planted by man as shown in Figure 1. In other words, it is man-made pasture, where suitable land is selected, cleared, cultivated, harrowed, seed bed prepared and seed sowed either through drilling or broadcasting. The seeds are provided with good environment such as moisture, light and oxygen to support germination. After the emergence of seeds, other cultural activities are carried out to ensure good seedlings establishment and growth (Olawoye and Kubkomawa, 2018).

Natural pasture refers to an area of land covered with forage grasses and legumes which are not planted by man as shown in Figure 2. It is the one that land is allowed fallowed for years and the plants established themselves without any human effort.

Forage Crops

These are crops cultivated or grown naturally and used purposely as feed for ruminants as shown in Figure 3. Livestock are allowed to either graze on them or are harvested and preserved as hay or silage. Silage is forage preserved in a succulent condition by partial anaerobic acid fermentation while hay refers to the dried form. Hay can be grass or other forage crops such as clover or alfalfa that is cut and dried as fodder (Zambrano et al., 2015; Olawoye and Kubkomawa, 2018).

Range Land

Range land refers to an extensive scrub-land or tract of land over which animals can roam and graze as can be seen in Figures 4 and 5. In range land, the herbage is generally natural pasture but various

Figure 1. Artificial Pasture (Source: Wikipedia).

Figure 2. Natural Pasture (Source: Wikipedia).

improvements may be made on the land to sustain the animals and conserve land resources. Range-lands abound in the areas of low rainfall, in the Sudan and Savannah belts of West Africa. Ordinary land which is unsustainable for food crop production may be utilized as range-land. These include

Figure 3. Forage Crop (Source: Wikipedia).

Figure 4. Range Land (Source: Wikipedia).

mountain slopes, arid lands and plateaux (Olawoye and Kubkomawa, 2018).

Range land is important because it covers about 23% of the land surface in the tropics and it is vital, or often the only resource, for ruminant animal production in the dry (cold) climate. Range lands

Figure 5. Goats Grazing on the Range Land (Source: Wikipedia).

occur in all types of climate and they originated as natural grasslands, as a result of grazing and burning of abandoned crop lands after forest clearing. Grazing is not the only use of range lands, mining, recreation and reserves for indigenous people are other uses of range land (Olawoye and Kubkomawa, 2018).

Range Management

Range management concerns grazing, burning and the control of woody plants (Maundu and Tegnas, 2005). The range land ecosystem is a complex of interaction because the soil, climate, vegetation, and the animal management play a decisive role with the ecosystem because they determine the condition of rangeland and thereby, also, the productivity (Olawoye and Kubkomawa, 2018).

Hence, the objective of range management is to obtain the maximum livestock production from range land and conservation of land resources. Good range management may be achieved by giving consideration to the following factors:

Type of Animal

Although animals may be grazed separately, maximum utilization of range land can be achieved by grazing a mixture of stock such as cattle, sheep and goats. In any case, in the choice of animals the following must be considered: topography (sheep and goats thrive better on rocky slopes than cattle), availability of water (sheep and goats can thrive better than cattle in poor water resource areas because of their sizes, weights and level of consumption), vegetative cover (sheep and goats browse on short herbage while cattle prefer tall herbage because of their feeding habits, bulk of feeding and the stomach sizes), poisonous plants (certain plants are known to be poisonous to some species of farm animals and where found, may restrict the use of the range land for grazing e.g goats tolerate bitter taste more than cattle and sheep) (Olawoye and Kubkomawa, 2018).

Stocking Rate or Density

This is the number of animals allowed to graze on a given area of range land without destroying the land resources. A general trend is that, the higher the number of stock on a given area, the lower the rate of herbage development. Where the stocking rate or density is very high, herbage is utilised frequently and this may lead to poor regeneration or death of the plant species. However, in some range lands, areas with richer herbage may be grazed more often than others. In other words, stocking rate is the number of livestock units per hectare and

determines the amount of feed that will be utilized. The higher the stocking rate, the more of the feed that will be consumed, but also fouled and trampled; whilst the ability of the animals to select the most palatable and nutritious parts of the vegetation decreases. Increased stocking rate will, therefore, lead to reduced production per animal. However, with more animals per hectare, the production per hectare will first increase, till a maximum is reached and subsequently decrease till a point of no gain is reached and eventually weight loss occurs. Conversely, with decreasing stocking rate, production per animal will increase to a maximum which is determined by the genetic potential of the animal and the quality of the feed. Stocking rate should be determined by the carrying capacity, but the optimum can be based on ecological or economic considerations. The ecological optimum is highly variable and depends on the rainfall, the forage reserve, the annual production system and the proper use factor. Proper use is the degree of grazing which ensures the fullest use of forage while maintaining growth, vigour and reproduction of the herbage, taking into account the conservation of the soil and other land uses (Olawoye and Kubkomawa, 2018).

Soil Condition

The stability of the soil and its susceptibility to breakdown are important factors in range land management. For example, light soil with poor vegetative cover is easily trampled and reduced to dust. This is easily observed on cattle tracts in the savannah belts. This factor is seriously considered when determining the stocking rate and frequency of use (Olawoye and Kubkomawa, 2018).

Forage Resources

The species of plants in the range land places a limit to the rate of growth of herbage that can be expected. Some species grow and regenerate faster than others e.g. elephant grass versus gamba grass (Heuzé and Tran, 2015). The richness of the forage is important in determining the rate of utilization of the range land (Cook et al., 2005; Olawoye and Kubkomawa, 2018).

Season of Use

While it is desired to provide all year round grazing on the rangeland, yet this may not be possible in certain seasons. Therefore, animals may be fed on fodder while the range land is allowed to rest and regenerate (Olawoye and Kubkomawa, 2018).

System of Use

In order to keep the range in good condition, ranchers may adopt one or more of the following systems of grazing:

Rotational Grazing: The range land is divided up into units which are fenced off. Animals are concentrated in one unit over a certain period, after which they are removed to another unit and the former is allowed to rest and regenerate. Pests and disease organisms die off during the period (Olawoye and Kubkomawa, 2018).

Deferred Grazing: The range land is divided up into units in one year, one unit is left completely unused. During the rest period, herbage grows, matures and yield seeds which germinate and produce seedlings, the seedlings are allowed to establish before the animals are put into the unit again (Olawoye and Kubkomawa, 2018).

Continuous Grazing: The animals are allowed to graze continuously on the range land over a period of time after which it is closed to them. This is possible where seasonal migration is practiced (Olawoye and Kubkomawa, 2018).

Over-grazing*:* Over-grazing represents an environmental hazard whereby livestock excessively feeds on pasture. It is, also, the practice of grazing livestock on vegetation before it has recovered from a former grazing state, also known as intensive grazing. Otherwise stated, over-grazing takes place when vegetation or pasture is repeatedly removed from land and it is not given enough time to regrow. Intensive grazing, thus, causes the plant residual matter to decline and further contributes to numerous negative consequences to both the animals and the land. Consequently, over-grazing signifies a serious environmental challenge in maintaining the natural balance of livestock on grazing lands, which reduces the productivity, usefulness, and bio-diversity of the land (Olawoye and Kubkomawa, 2018).

GRAZING SYSTEMS

Grazing management deals with such questions as how long should animals stay in one area and how

Figure 6. Continuous Grazing of Dairy Cows on the Natural Pasture Land (Source: Wikipedia)

long they should stay off it; which animals should graze what pasture; how many animals should graze together and what other activities should be integrated with grazing. Grazing management and stocking rate are the two most important variables affecting herbage production, seasonal pattern of production, herbage quality and botanical composition. The most common grazing systems are:

Continuous Grazing System

This is the grazing management whereby animals are confined within a single enclosed pasture area for the entire growing season, which may be a full year as shown in Figure 6. The application of this system to the range results in under-grazing in wet season and over-grazing in the dry season. The pasture could either be set or variably-stocked. In the set-stocked system the number of animals are kept constant, where in the variably-stocked, the number of animals are varied according to the pasture growth but the pasture is always been grazed (Olawoye and Kubkomawa, 2018).

Advantages of the Continuous Grazing System

(i) Swards are likely to be more persistent
(ii) Less fencing is needed
(iii) Has denser swards with greater resistance to poaching or trampling

Disadvantages of the Continuous Grazing System

(i)Young stock are exposed to helminth parasites which retard their growth
(ii) Favours the building up of ticks on pastures
(iii) Nematode infestation is high

This system is, also, called the put-and-take grazing system. It offers less control than others and calls for less interference. Among the different grazing management systems, the continuous system is encouraged with most tropical pastures because of the ease in management and higher animal production.

Rotational Grazing System

This system requires sub-division of the pasture into a number of enclosures (Fences/Paddocks) with an additional paddock more than the groups of animals (Figure 7). It is an intensive system practiced on improved pastures. Animals are moved systematically from one paddock to another in

Figure 7. Rotational Grazing of Beef Cattle Using Electric Fence (Source: Wikipedia).

rotation. The time taken to graze in every paddock varies from 3-7 days and takes 8 weeks before re-grazing. This time intervals will depend on the stocking rate, pasture production, species/cultivars of pasture plants, the climate, season and soil type (Akinlade et al., 2002; Olawoye and Kubkomawa, 2018).

Conservation of forage is possible and easier in this system if the animals cannot cope with the growth of the pasture. This system when accompanied by conservation practices is an ideal way to maintain high pasture yield. The stocking rate is usually high on pastures such as signal grass (*Brachiaria decumbens*), pangola (*Digitaria decumbens*) and star grass (*Cynodon Spp*) because of their ability to withstand heavy grazing and faster regeneration than other species (Bulakali et al., 2013; Olawoye and Kubkomawa, 2018). Milking cows are used mostly in this grazing system. As in the continuous, the rotational grazing system can be either set-stocked or variably-stocked. A particular form of a rotational system may be of utmost value for a particular purpose than another form. Rotational grazing is good for irrigated pastures (Olawoye and Kubkomawa, 2018).

Advantages of the Rotational Grazing System

(i)There is greater flexibility in matching the supply of grass to the requirement of the animals
(ii) More suitable to dry season calving calves
(iii) Easy matching to small field
(iv) Less time needed for moving animals

Disadvantages of the Rotational Grazing System

(i) It is capital intensive at the initial stage because of the facilities required and the sub-division of the pasture into a number of enclosures (Fences/Paddocks).

Rotational Differed Grazing System

In this modification, the system recognizes the critical periods in the phenology (stages of development) of the desirable plants in the pastures such as seed germination, seedling establishment, flowering and seed set and periods of storing food in the root and crown regions of the plants as shown in Figure 8 (Bulakali et al., 2013; Olawoye and

Figure 8. Rotational Differed Grazing System (Source: Wikipedia).

Kubkomawa, 2018).

Advantages of the Rotational Differed Grazing System

(i) This method allows each enclosure to be freed from grazing during at least one of the critical periods or for longer periods within the grazing year.
(ii) It's useful under range land condition since it allows accumulation of fuel for a good fire in order to control tree and shrub spp.

Disadvantages of the Rotational Differed Grazing System

(i)One limitation of this system is the suppression of the legumes by taller grasses in a mixed pasture, thus, changing the balance of the species present.

Strip Grazing System

Dairy animals are commonly strip grazed on highly productive pastures in order to ration the amount of forage needed by the animal for part of a day or a whole day. The animals are prevented from entering pastures ahead and going back to the already grazed strips by the use of electric fences as shown in Figure 9 (Olawoye and Kubkomawa, 2018).

Advantages of the Strip Grazing System

(i)Feed is easily rationed, especially, when it is scarce.
(ii) Herbage selection by animals is reduced.
(iii) The re-growth is prevented from being re-grazed.
(iv) There is reduction in wastage associated with trampling and defoliation .
(v)Prevention of bloat in growing animals.

Disadvantages of the Strip Grazing System

(i) It is expensive in terms of facilities.

Rotational Creep Grazing System

This is, also, referred to as the leader-follower system of grazing. In this modification of rotational grazing system, highest producing animals such as milking or lactating animals will be able to select forage highest in quality for optimum production. They are followed by the other classes of livestock with less demand, for example, dry cows or beef animals, while the leaders move to another grazing unit as can be seen in Figure 10 (Olawoye and Kubkomawa, 2018).

Advantages of the Rotational Creep Grazing System

(i)This practice gives satisfactory utilization and uniform re-growth of the pasture.
(ii) The leaders could, also, be lambs or young calves grazing ahead of ewes and adult cows.
(iii) In this system, better control of worm infestation is possible.

Figure 9. Strip Grazing of Goats Using Barbed Wire (Source: Wikipedia)

Disadvantages of the Rotational Creep Grazing System

(i)Creeps are designated to all the entrances of young calves or lambs and it requires capital to achieve that.
(ii) At times, the head of an animal would get caught on the creep which may lead to injury and death.

Zero Grazing

It is, also, known as green soiling, cut-and-carry or mechanical grazing system. It entails cutting the herbage and feeding it to the animals in pens as can be seen in Figure 11 (Olawoye and Kubkomawa, 2018).

Advantages of the Zero Grazing System

(i) Higher efficiency and uniformity of forage utilization because wastage from trampling is avoided.
(ii) Energy expended by animals in grazing is reduced and thereby achieving higher productivity.
(iii) There is higher forage growth rate as a result of reduced trampling damage to the soil.
(iv) Economically, less labour is required in conveying herd to and from the field, while division of pasture by fence and provision of water on the field are not required.

Disadvantages of the Zero Grazing System

(i)High labour is required in cutting and distribution of forage and removal and disposal of dung
(ii) High capital inputs in form of yards, structures and equipment for the feeding areas and fuel for the operators.
(iii) Animal's opportunity for forage selection is reduced, hence affecting intake, preference and digestibility of tropical forages.
(iv) Animal's opportunity for exercise is also reduced.

AGRO - ECOLOGICAL ZONES OF NIGERIA

Nigeria is in the Tropics, where the climate is seasonally damp and very humid. The natural vegetative zones that exist in the country are governed by the combined effects of temperature, humidity, rainfall and particularly, the variations that occur in the rainfall. This forms a major influence on the type of indigenous plants that grow successfully in different parts of the country (Olawoye and Kubkomawa, 2018).

The humid tropical forest zone of the South that

Figure 10. Rotational Creep Grazing of Sheep (Source: Wikipedia).

Figure 11. Zero Grazing of Dairy Cows (Source: Wikipedia).

has longer rains is capable of supporting a number of plantation crops such as cocoa, oil palm, rubber, coffee, cotton and staple crops like, yam, cassava, cocoyam, sweet potatoes, melon, groundnut, rice and maize. However, in some parts of the East and many areas near the coast, the high rainfall has led to badly leached soils and severe erosion in some places.

The Northern part of the country which represents about 80% of the vegetative zones, experience

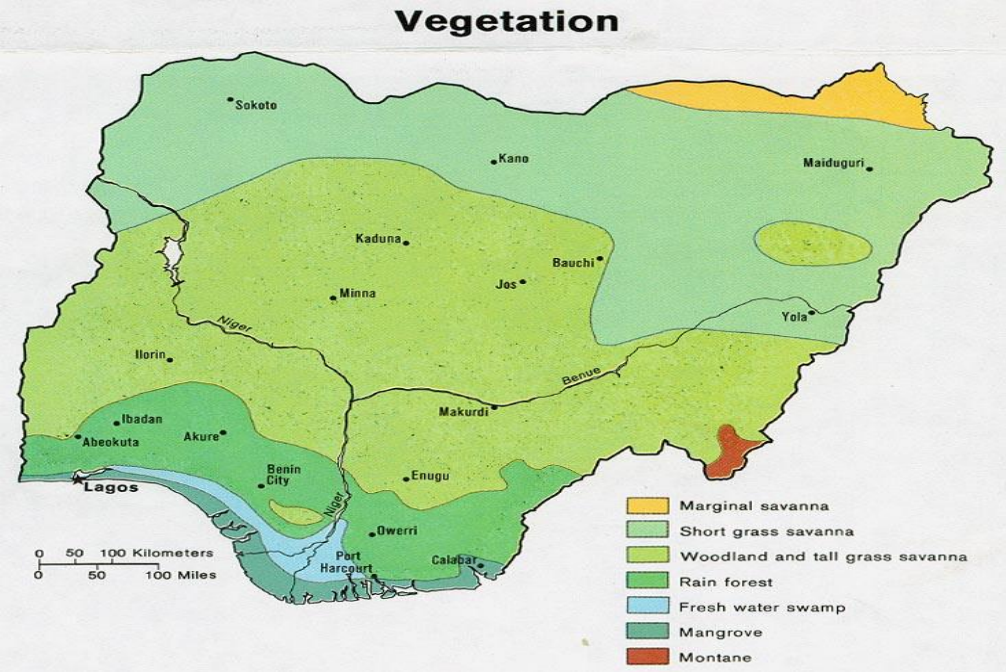

Figure 12. Map of Nigeria Showing the Agro-Ecological Zones (Source: Wikipedia).

lower annual rainfall and shorter rainy season and they make up the Savannah lands. The Savannah land forms an excellent natural habitat for a large number of grazing livestock such as cattle, goats, sheep, camels, horses and donkeys.

The natural vegetative zones resulted from the interaction of climate, humidity, rainfall and soils. These factors have been modified by human activities and man's pattern of land use. Based on total annual rainfall, Nigeria's agro-ecological zones can be classified into:

The Sahel savannah (Marginal Savannah); The Sudan savannah (Short grass savannah); The Guinea Savannah; The derived Guinea Savannah (Wood-land and Tall grass savannah); The tropical rain forest zone; The Freshwater swamp forest; The Mangrove forest and coastal vegetation; The Montane vegetation as shown in Figure 12.

The Sahel Savannah (Marginal Savannah)

This is the last agro-ecological zone with proximity to the fringes of the fast- encroaching Sahara desert (Olawoye and Kubkomawa, 2018). It occupies about 18, 130 km^2 of the extreme North-East corner of Nigeria and is the last vegetation zone in the extreme Northern part of the country, close to Lake Chad, where the dry season lasts for up to 9 months and the total average annual rainfall is hardly up to 700mm per annum. Here, the vegetation is not only sparse but the grasses are very short. As a rule, this zone is not cultivated without irrigation. The people found in this zone are the nomadic herdsmen. They are careful not to burn the grass found there because sparse as it is, it provides the only pasture available for their grazing livestock. It is characterized by very short grasses of not more than 1m high located in between sand dunes (Adjolohoun et al., 2008). The area is dominated by several varieties of the Acacia and Date palms. The Lake Chad basin, with its seasonally flooded undulating plains, supports a few tall trees. At the same time, the drainage system of rivers and streams into the Lake Chad basin has favoured irrigation, without which cultivation would be virtually impossible. The increasing aridity in the area accounts for the progressive drying up of the Lake Chad (Figure 13).

The Sudan Savannah (Short Grass Savannah)

The Sudan Savannah zone is found in the North-West stretching from the Sokoto plains in the West, through the Northern sections of the Central

Figure 13. The Sahel Savannah (Marginal Savannah) (Source: Wikipedia).

highlands. It spans almost the entire Northern States bordering the Niger Republic and covers over ¼ of Nigeria's total land area (Olawoye and Kubkomawa, 2018).

The low average annual rainfall of 657.3mm and the prolonged dry season (6-9months) sustain fewer trees and shorter grasses than the Guinea Savannah. It is characterized by abundant short grasses of 1.5 - 2m and few stunted trees hardly above 15m. It is by far the most densely human populated zone of Northern Nigeria. Thus, the vegetation has undergone severe destruction in the process of clearing land for the cultivation of important economic crops such as cotton, groundnut, sorghum, millet, maize and wheat. The grass vegetation is interspersed with farms and thick bush trees such as Shea Butter tree (*Butyrospermum parkii*) and *Acacia albida* (Ndemanisho et al., 2006). Also found in the zone are the Locust Bean trees (*Parkia filicoidea*) and Tamarind trees (*Tamarindus indica*) and Mango (*Mangifera indica*) (Amanullah et al., 2006). A large portion of this zone falls within the Tsetse Fly free belt of West Africa and it is excellent for the rearing and breeding of ruminant livestock (cattle, goats, sheep, donkeys, horses and camels). The nomadic Fulani roam about this zone in search of fodder and water for their livestock as shown in Figure 14.

The Guinea Savannah

The Guinea Savannah, located in the middle of the country, is the most extensive ecological zone in Nigeria, covering nearly ½ of the country (Olawoye and Kubkomawa, 2018). Guinea savannah zone has a unimodal rainfall distribution with the average annual temperature and rainfall of 27.3ºC and 1051.7mm, respectively, where the wet season lasts for 6–8months. This zone consists of the larger part of the savannah zone and is sometimes divided into the Southern Guinea Savannah and Northern Guinea Savannah. It is the broadest vegetation zone in the country and it occupies almost ½ of its area. It extends from Northern part of Ondo, Edo, Anambra and Enugu States in the South, through Oyo State to beyond Zaria in Kaduna State. It is a belt of mixture of trees and tall grasses in the South, with shorter grasses and less trees in the North (Murphy, 2010). The Guinea Savannah, with its typically short trees and tall grasses, is the most luxuriant of the Savannah vegetation belts in Nigeria. The zone is characterized by low rainfall and long dry period, which call for alternative water supply (irrigation) to enhance full utilization of the

Figure 14. The Sudan Savannah (Short Grass Savannah) (Source: Wikipedia).

zone's potential in agricultural production.

The Guinea savannah is characterized by grasses such as *Pennisetum p.*, *Andropogon g.*, *Panicum m.*, *Chloris g.*, *Hyparrhenia*, *Paspalum* and *Melinis* (Nworgu and Egbunike, 2013). These tall grasses are characteristic of the Guinea Savannah proper (Obua et al., 2012).

In the Northern Guinea Savannah, species such as *Isoberlinia doka* and *I. tomentosa* form the bulk of the scattered wood-land. Also found are Locust Bean trees (*Parkia filicoidea*), Shea Butter trees (*Butyrospermum parkii*) and Mango (*Mangifera indica*) (Baligar and Fageria, 2007).

Comparatively, there are fewer trees in the Northern Guinea Savannah than in the Southern Guinea Savannah and the trees are not as tall as those found in the Southern Guinea Savannah. Most of the tall grasses found in the derived Guinea Savannah, are also found in the Guinea Savannah, however, they are less luxuriant (Orodho, 2006). The appearance of this zone differs from season to season. During the rainy season, the whole zone is green and covered with tall grasses that grow and reach maturity rapidly and thus become fibrous and tough. In the dry season they tend to die and disappear and one can see several kilometres away without obstruction. This clearly is due to several periodical bush-burning that occurs during the dry season between November and April, which is carried out to either assist in farm clearance or hunting (Figure 15).

The Derived Guinea Savannah (Wood-land and Tall Grass Savannah)

This zone is found immediately after the tropical rainforest zone (Olawoye and Kubkomawa, 2018). It is the transition between the tropical rainforest and guinea savannah zones. The average annual rainfall and temperature are 1314mm and 26.5ºC, respectively. Due to bush burning, over-grazing, cultivation and hunting activities over a long period in the zone, the high forest trees were destroyed and the forest that used to exist is now replaced with a mixture of grasses and scattered trees (Moore, 2006; Heuzé and Tran, 2016; Heuzé et al., 2017). The zone is covered with scattered trees and tall grasses. Maize, Cassava, Yam and Rice are the major crops grown in this zone. The savannah zone in general has an enormous potential for food production in the country. Bush burning and erosion as a result of over-grazing by animals, especially cattle constitute a major problem to agricultural production in the zone (Figure 16).

Figure 15. The Guinea Savannah (Source: Wikipedia).

Figure 16. The Derived Guinea Savannah (Wood-land and Tall Grass Savannah) (Source: Wikipedia).

The Tropical Rain Forest Zone

This area is characterized with a prolonged rainy season, resulting in high annual rainfall above 2000mm, thereby ensuring an adequate supply of water and promoting perennial tree growth

Figure 17. The Tropical Rain Forest (a) (Source: Wikipedia).

(Olawoye and Kubkomawa, 2018). This luxuriant vegetation belt stretches from the western border of Nigeria to Benin Republic, through a narrow stretch on the Niger-Benue river system into the extensive area in the South-East of the country. This zone is the major source of timber for the large construction and furniture making industry. Of all the zones, it contains the most valuable species of vegetation. However, due to human activities, this one-time highly forested area has been drastically reduced. Bush fallows, villages and farms are found scattered throughout the zone. Presently, the drier end of its inland side is becoming reduced to derived Guinea Savannah because of tree felling and clearings. In the humid rain forest are found economic cash crops such as Oil Palm, (*Elaeis guineensis*), Cocoa (*Theobroma cacao*), Rubber (*Hevea brasiliensis*) Banana/Plantain (*Musa* spp.) and Cola nut (*Cola nitida*). Also found are some principal staple food crops such as yam, cocoyam, sweet potato, maize, rice, groundnut, cowpeas and beans as well as a number of fruits. A number of timber trees such as the African mahogany, the scented Sapele wood (*Entandrophragma cylindricum*) and Iroko (*Chlorophora excelsa*) are found in this zone. This zone therefore, is very important in terms of food production and timber for construction and cabinet making as shown in Figures 17 and 18.

The Freshwater Swamp Forest

This area lies immediately inland of the mangrove swamp but on a slightly higher ground. This vegetation belt, on freshwater wet-lands occur further inland, beyond the reach of tidal waters. The lagoons or the rivers that overflow their banks in the wet season supply it with fresh water because the area is low lying, therefore, it is flooded with rain water and lies under rain for most part of the year, 8 or 9months of the year (Olawoye and Kubkomawa, 2018).

The area of the country under this agro-ecological zone, are Ogun, Benin, Imo, Niger Delta and Cross River. There is high influx of water deposits, vast quantities of silt, mud and sandy materials into this area. It is a low lying region, with hardly any part rising over 30m above sea level, thus, it facilitates the development of fresh-water swamps along the Niger Delta, drowned estuaries, lagoons and creeks. This zone consists of a mixture of trees. Important among the vegetation of this zone are the various Palm and Fibre plants such as *Raphia* spp., *Raphia vinifera*, the Wine Palm and *Raphia hookeri*, the Roof-mat Palm. They are used for thatching mats

Figure 18. The Tropical Rain Forest (b) (Source: Wikipedia)

and for providing rafter, poles and stiff fibre for the production of brooms. The better drained areas support Oil Palm trees (*Eleais guineenais*) and big trees like Iroko (*Chlorophora exceisa*). Fishing and fibre-making are the important vacations of the fresh-water swamp communities (Figure 19).

The Mangrove Forest and Coastal Vegetation

This is found in places near the coast, under the influence of brackish water commonly found in the Niger Delta (Olawoye and Kubkomawa, 2018). It is, also, found in low lying swamp land associated with rivers and lagoons near the coast and under the influence of the sea. Soil in the mangrove area is poorly aerated with water-logged mud and is high in salt content due to the constant flooding by the sea. The coastal swamp area is not widely cultivated except for swamp rice in places where they are stabilized and non-saline (Figure 20).

Montane Vegetation

The Montane zone is located in the high altitude areas of the country like Jos Plateau, Mandara and Adamawa Mountains and the Obudu Plateau (Olawoye and Kubkomawa, 2018). The zone is characterized by low average annual temperature (21.5ºC). The average annual rainfall is 1450mm. The Montane zone vegetation is covered with grass at the top and base, while forests cover the slopes, favoured by moisture-laden wind. The zone has a great potential for the cultivation of maize, wheat, carrot, cabbage and other exotic vegetables but the mountainous nature of the zone prevents commercial farming. The Fulani, who live in great numbers in the area, turn the available fields into good pasture for their grazing animals.

The main constraints on feed resources in all the zones are the destruction of perennial tree cover for firewood, bush fires caused by hunters; livestock rearing and over-grazing. These man-made constraints often lead to serious degradation of the pastoral resources and in some cases to an irreversible process of desertification, especially in the Sahel zone as shown in Figure 21.

Conclusion and Recommendations

Ruminant animals, especially cattle, sheep and goats are natural grazers and possess remarkable ability to digest plant carbohydrates that is generally indigestible by most other mammals. It is natural

Figure 19. The Freshwater Swamp Forest (Source: Wikipedia).

Figure 20. The Mangrove Forest and Coastal Vegetation (Source: Wikipedia).

then to assume that, grazing is the best way to supply a nutrient-dense diet to ruminant animals. Pasture land with high quality grass-legume can meet energy requirements of growing or lactating ruminants in the wet season. Energy supplementation on pasture helps in maintaining

Figure 21. The Montane Vegetation (Source: Wikipedia).

high grains and milk production. High quality forages have the ability to supply all the energy needed to maintain highly-productive ruminants throughout the growing season, but only when managed intensively. Legume-grass pasture has protein content greater than 18% during the vegetative stage.

Feed resources that contain minerals include; range or pasture plants, harvested forages, concentrates and mineral supplements. The levels of minerals in plants are a function of interaction between several factors which include soil type, plant species, stage of maturity, dry matter yield, grazing management and climate.

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